REMARKS

This amendment is submitted in response to a final rejection. Entry of this amendment is requested because the amendment places the application in better form for consideration on appeal.

Claims 1, 5, 6, 8-12, 17 and 20-27 are pending in this application. Claims 1-5, 6, 8-12, 17, and 20-24 and 26-27 have been rejected. Claim 1 has been amended. Claim 25 was indicated to be rejected on the form PTO-326, but claim 25 was objected to in the office action.

Claims 1 and 9-12 have been rejected under 35. U.S.C. §102(b) as being anticipated by *Schetzina* (U.S. Patent No. 5,351,255).

Claim 1 has been amended to recite in pertinent part "an intermediate layer formed on said electrode of the one conductivity type, made of at least one of In, Ag, Ni and Cr." Support for the intermediate layer is found in the specification as the layer 3120. The intermediate layer made of at least one of In, Ag, Ni and Cr may reduce the thermal strain of the active layer and improve reliability. (Patent Application, p. 17, lns. 26-32.)

As understood, *Schetzina* at best merely discloses a substrate 103 having a metal electrode 104 disposed thereon. (Col. 19, lns. 3-17, Fig. 26B.) The bonding layer 106 is formed between the electrode 104 and an ohmic metal electrode 13, as shown in Figure 26B. The bonding layer 106 is formed of conducting epoxy or solder. (Col. 19, lns. 12-15.) The bonding layer 106 of *Schetzina* is not the "intermediate layer formed on said electrode of the one conductivity type, made of at least one of In, Ag, Ni and Cr" recited in amended claim 1.

It is noted in the Office Action that the intermediate layer 106 of *Schetzina* contains Ag. However, as understood, *Schetzina* has no description that the layer 106 contains Ag. *Schetzina* teaches that the layer 106 is made of conducting epoxy or solder. It is asserted in the Office Action that epoxy or solder inherently contains Ag.

However, even if an epoxy or solder contains Ag or a Ag paste, an assertion that the Applicant does not concede, the thermal resistance of the epoxy and the thermal bonding stress of the solder is higher than that of the intermediate layer specified in claim 1. Therefore, the intermediate layer 106 of *Schetzina* cannot reduce the thermal strain of the active layers.

Lacking at least this claimed feature, *Schetzina* cannot render amended claim 1 unpatentable. Because claims 9-12 depend on claim 1, for similar reasons *Schetzina* cannot

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render claims 9-12 unpatentable. Therefore, it is respectfully submitted that claims 1 and 9-12 are patentable over the references of record.

Claims 5 and 8 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over *Schetzina*. This rejection is respectfully traversed.

Claims 5 and 8 are dependent on claim 1. Lacking the disclosure or suggestion of a claimed feature in the independent base claim 1, *Schetzina* cannot render dependent claims 5 and 8 unpatentable for being obvious over *Schetzina*. Therefore, it is respectfully submitted that claims 5 and 8 are patentable over the references of record.

Claim 6 has been rejected under 35 U.S.C. §103(a) as being unpatentable over *Schetzina* in view of *Biing-Jye et al.* (U.S. Patent No. 6,169,294). This rejection is respectfully traversed.

Claim 6 depends on amended claim 1.

Schetzina is described above. *Biing-Jye et al.* does not disclose the intermediate layer recited in amended claim 1, nor has it been cited as disclosing such feature. *Biing-Jye et al.* has been cited for disclosing "a light-emitting device having an n-GaN contact layer between the light-emitting layer and the n-type electrode" as shown in Figure 3. An insulating layer SiO_2 is formed on the substrate N-Si. A metal contact is formed on the insulation layer, with a solder #2 layer on the metal contact. A p-ohmic layer is formed on the solder #2 layer with a p-GaN contact layer on the p-ohmic layer as shown in Figure 3.

However, none of these layers are the intermediate layer recited in amended claim 1. Neither *Schetzina* nor *Biing-Jye et al.* disclose or even suggest, individually or in combination, the intermediate layer recited in amended claim 1, and thus do not render claim 6, which depends on claim 1, unpatentable.

Therefore, it is respectfully submitted that claim 6 is patentable over the references of record.

Claim 17 has been rejected under 35 U.S.C. §103(a) as being unpatentable over *Schetzina* modified by *Biing-Jye et al.*, and further in view of *Takahashi et al.* (U.S. Patent No. 5,360,762). This rejection is respectfully traversed.

Schetzina and *Biing-Jye et al.* are described above. *Takahashi et al.* at best merely discloses a cap layer 42 having a recess as shown in Figure 6(d). Because *Takahashi et al.* discloses a laser device, the recess is not formed to improve light extraction efficiency, but rather to improve the light confinement efficiency. Therefore, *Takahashi et al.* does not teach the

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"light-reflecting electrode formed on the recessed surface of said contact layer" as recited in claim 17, which contributes to the improved light extraction efficiency.

Claim 17 specifies the contact layer formed on the double-heterostructure and having the recessed surface, and the light-reflecting electrode formed on the recessed surface of the contact layer. In an illustrative example, the contact layer corresponds to the layer 305, and the light-reflecting electrode corresponds to the electrode 307 of the ninth embodiment shown in Fig. 13.

According to claim 17, light emitted by the active layer is reflected by the light-reflecting electrode formed on the recessed surface of the contact layer, and extracted outside from the side surface of the element. Specifically, the contact layer having the recessed surface allows the extraction of light from the light-emitting layer to the exterior.

In contrast, the cap layer 42 having a recess of *Takahashi* shown in Fig. 6(d) is formed not to extract light from the element to the exterior, but to confine light inside the element. Because the element of *Takahashi* is a laser device, it is necessary to improve the light confinement efficiency, unlike the LED element of claim 17.

Neither *Schetzina, Biing-Jye* nor *Takahashi* disclose the contact layer having the recessed surface that extracts lights and contributes to the improved light extraction efficiency.

Neither *Schetzina, Biing-Jye et al.*, nor *Takahashi et al.* disclose or even suggest, individually or in combination, at least this claim feature as recited in claim 17, and thus these references cannot render claim 17 unpatentable. Therefore, it is respectfully submitted that claim 17 is patentable over the references of record.

Claim 20 has been rejected under 35 U.S.C. §103(a) as being unpatentable over *Schetzina* in view of *Bour et al.* (U.S. Patent No. 5,977,612). This rejection is respectfully traversed.

Claim 20 recites a semiconductor light-emitting diode. A laser diode is not included in the scope of claim 20.

Schetzina is described above. As understood, *Bour et al.* at best discloses a laser diode as shown in Figures 2(a) and 2(b) and described at column 6, lines 41-49. The upper distributed Bragg reflector (DBR) layer 114 allows the transmission of light for the laser. (Column 5, lines 28-31).

Thus, *Bour et al.* discloses as shown in Figures 2(a) and 2(b) a laser diode that extracts light from only the top surface, and does not extract light from the end surface. Specifically, light is confined inside the end surface of the laser.

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This laser diode of *Bour et al.* is not a light-emitting diode as recited in amended claim 20. The light-emitting diode of claim 20 can extract light from the end surface to improve light extraction efficiency.

In contrast, the light-emitting diode set forth in claim 20 extracts light from the end surface to improve the light extraction efficiency.

Lacking the disclosure or suggestion of at least this claim feature, neither *Schetzina* nor *Bour et al.* either individually or in combination can render claim 20 unpatentable. Therefore, it is respectfully submitted that claim 20 is patentable over the references of record.

Claims 21-23 and 26-27 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Schetzina* in view of *Suzuki et al.* (U.S. Patent No. 5,253,264). This rejection is respectfully traversed.

Schetzina is described above. As understood, *Suzuki et al.* at best merely discloses an integrated LED device having a differential grating formed on a layer 3B of a multiple quantum well. The quantum well 3B is asserted to be a photonics crystal layer.

Claims 21-23 and 26-27 each recite a light-emitting element comprising a photonics crystal layer.

The light-emitting element according to claims 21-23 and 26-27 includes a photonics crystal layer. *Suzuki et al.* does not relate to a photonics crystal layer. Specifically, a diffraction grating, which is recited in *Suzuki et al.*, is not a photonics crystal layer as recited in claims 21-23 and 26-27.

It is noted in the Office Action that *Suzuki et al.* discloses a LED device having a diffraction grating. However, a diffraction grating is different from a photonics crystal layer, and *Suzuki et al.* does not discloses an LED element, but instead discloses a laser device.

It may be helpful to note the difference between a photonics crystal layer and a diffraction grating.

As described on page 24, lines 24-35 of the patent application, photonics crystals have a periodic gradient index in a medium, and photonics crystals have two-dimensional and three-dimensional structures in general to enhance the effect.

A diffraction gradient constant of photonics crystals is about a half wavelength of light, and a photon severely interferes with the periodic gradient structure. The extent of interference depends on a grading constant, dielectric constant, and a grating structure.

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An important feature of a photonics crystal is that it has a bandgap. No optical state exists in the bandgap, and thus light having photon energy corresponding to the bandgap does not exist in the crystals.

Consequently, light, which has a wavelength, is reflected by the photonics crystal layer.

A diffraction grating, such as used in the laser device as disclosed in *Suzuki*, has only a one-dimensional periodic gradient index. A diffraction grating diffracts light having a predetermined wavelength based on a property of light in which a diffraction angle of light depends on its wavelength.

In contrast to a photonics crystal, a diffraction grating in the laser of *Suzuki et al.* has only a one-dimensional periodic gradient index. Therefore, the diffraction grating cannot confine light in a two-dimensional or three-dimensional state, and thus is different than a photonics crystal layer. Furthermore, the laser of *Suzuki et al.* allows light having a predetermined wavelength to propagate along the diffraction grating, but the diffraction grating does not reflect light.

Consequently, a diffraction grating in the laser device of *Suzuki et al.* and a photonics crystal layer of claims are quite different from each other in view of their constructions and their properties. Accordingly, *Suzuki et al.* does not disclose photonics crystals (nor does *Schetzina* as noted in the Office Action), and the grating does not improve the light extraction efficiency.

For these reasons, *Suzuki et al.* merely discloses a diffraction grating used in a laser device, and does not disclose the photonics crystal layer used in an LED element set forth in claims 21-23 and 26-27.

Thus, neither *Schetzina* nor *Suzuki et al.* disclose or even suggest, individually or in combination, the photonics crystal layer recited in claims 21-23 and 26-27, and therefore cannot render claims 21-23 and 26-27 unpatentable. Therefore, it is respectfully submitted that claims 21-23 and 26-27 are patentable over the references of record.

Claim 24 has been rejected under 35 U.S.C. §103(a) as being unpatentable over *Schetzina* in view of *Paoli et al.* (U.S. Patent No. 5,138,625). This rejection is respectfully traversed.

Schetzina is described above. As understood, *Paoli et al.* at best merely discloses a laser having active quantum wires 288 formed on grooves 278 as shown in Figure 12. The grooves 278 are not formed to reflect light emitted from the active quantum wires 288, but are used to form the wires 288. (Column 12, lines 1-15). Thus, light is extracted from a certain limited face,

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because it has a general layer structure. However, the laser of *Paoli et al.* cannot improve the light extraction efficiency.

The wires 288 is not the "interface of said contact layer in contact with said first cladding layer is corrugated to have a gradient index" as recited in claim 24.

It is asserted in the Office Action that *Paoli* discloses an LED having a corrugated interface between the contact layer 300 and cladding layer 296.

Applicant respectfully disagrees with this characterization of *Paoli*.

First, *Paoli* discloses a laser device, and does not disclose an LED element.

Second, the V-shaped grooves are formed on a surface or an active layer 288, in order not to reflect light emitted therefrom, but to form horizontal multiple Quantum wires and to confine light emitted therefrom.

Therefore, the layers 280 and 284 formed under the active layer 288, and the layers 292 and 296 above the active layer 288 can be manufactured by materials having low refractive index. As a result, a threshold current can be reduced. Namely, the V-shaped grooves of *Paoli* are not formed to improve a light extraction efficiency, but are formed to confine light and reduce a threshold current.

Consequently, *Paoli* does not disclose the contact layer whose interface is corrugated to have a gradient index as recited in claim 24.

Lacking at least these claimed features, neither *Schetzina* nor *Paoli et al.*, individually or in combination, can render claim 24 unpatentable. Therefore, it is respectfully submitted that claim 24 is patentable over the cited references.

Claim 25 has been objected to as being dependent upon on a rejected base claim, but would be allowable if rewritten in independent form. It is noted that claim 25 is an independent claim, and therefore, claim 25 does not require rewriting. Withdrawal of the objection to claim 25 and allowance of claim 25 are respectfully requested.

It is submitted that claims 1, 5, 6, 8-12, 17 and 20-27 are allowable, and allowance and issuance of this application is respectfully requested.

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Please address all future communications regarding this application to:

Edward B. Weller
GRAY CARY WARE & FREIDENRICH LLP
1755 Embarcadero Road
Palo Alto, CA 94303-3340

Please direct all telephone calls to Edward B. Weller at (650) 833-2436

Attached hereto is a marked up version of the changes made to the specification and claims by the current amendment. The attached page is captioned APPENDIX – MARKINGS TO SHOW CHANGES MADE.

Please charge any additional fees, including any fees necessary for extensions of time, or credit overpayment to Deposit Account No. **07-1896, referencing 2102401-900900.**

Dated: April 2, 2003

GRAY CARY WARE & FREIDENRICH LLP

By _____
Edward B. Weller
Reg. No. 37,468

GRAY CARY WARE & FREIDENRICH LLP
1755 Embarcadero Road
Palo Alto, CA 94303-3340
Telephone: (650) 833-2000
Facsimile: (650) 320-7401

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APPENDIX – MARKINGS TO SHOW CHANGES MADE

1. (twice amended) A semiconductor light-emitting element comprising:

a substrate;

an electrode of one conductivity type which is formed on said substrate;

an intermediate layer formed on said electrode of the one conductivity type, [containing] made of at least one of In, Ag, Ni and Cr;

a reflective layer which is formed on said intermediate layer, contains a metal, and reflects a light;

a light-emitting layer formed on said reflective layer to emit light, having a double-heterostructure in which an active layer is sandwiched between first and second cladding layers; and

a transparent electrode formed on said light-emitting layer to transmit light.

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